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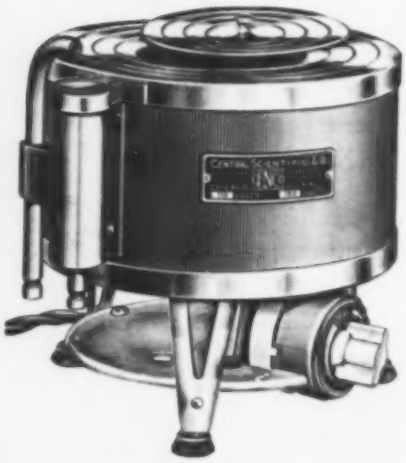

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Chinese Disturbances Bring to the Front the Question of Our Tung-Oil Supply

The Unsettled Condition of China Makes the Propagation of an American Tung Oil of Great Economic Importance

By J. FRANCIS COOPER
Florida Agricultural Experiment Station

A domestic tung-oil tree in full bloom

A CROP recently introduced into America and which seems destined to take an important place in American agriculture and manufacture is the Chinese tung-oil or wood-oil tree. It belongs to the genus Aleurites, and the most promising variety for American use seems to be Aleurites fordi Hemsl. The fruits of the tree bear seed which contain tung-oil or wood-oil, one of the best drying oils known. It is used in large quantities in the manufacture of paints and varnishes. Tung-oil tends to make varnishes waterproof and reduces their liability to crack. It is said that waterproof varnishes cannot be made satisfactorily on a commercial scale without tung-oil.

The only source of tung-oil up to the present has been China. The Department of Commerce estimates that in 1925 the United States imported 101,554,000 pounds

of tung-oil, valued at $11,386,000. However, the Chinese methods of extraction are crude, producing a low quality oil, which is often adulterated before it is shipped. It is produced in the interior of China, and is subject to heavy tax burdens and even to confiscation by bandits before it reaches the coast for shipping to America. At the present time the almost war-like unrest of the country, which bids fair to be of considerable duration, adds another complexity to the situation.

All of these factors have tended to make China an unsatisfactory source of supply, and consequently American manufacturers are interested in obtaining an American supply. In recent years, particularly, they have aided in endeavors to establish the crop in the Southern States.

The first plantings of tung-oil trees were brought to America in 1905 by the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture. It was first tried in California, but failed to do very well in that state. It has been tried also in a large number of Southern states, but has been found to thrive best in the northern part of Florida and the southern parts of Georgia, Alabama, Mississippi, and Louisiana. Above the central part of Georgia and Alabama, it is apt to be killed by cold in the winter.

The greatest development of tung-oil has taken place in Alachua County, Florida. Plantings were made on the farm of the Florida Agricultural Experiment Station in 1912, and in recent years two companies formed by the paint and varnish industry have developed the industry on a more extensive scale than has been done heretofore. These companies are the American Tung-Oil Corporation and the Alachua Tung-Oil Company. They and other Alachua County planters have about 3,000 acres set to tung-oil trees, some of whch are bearing. It is estimated by B. F. Williamson, in charge of the properties of both companies, that 30,000 trees will bear fruit this year, and approximately 160,000 will be in bearing by 1928. As soon as enough crop is being produced to justify it, a crushing mill is planned for the county.

Plantings have been made also by these and other companies and by individual farmers in the central and northern part of Florida, southern Georgia, and the Gulf regions of Alabama, Mississippi, and Louisiana.

The tung-oil tree is a straggly growing deciduous tree, the leaves of which are large, dark green, and more or less heart shaped, often with three lobes. The tree grows to a height of from 25 to 35 feet, and measures from 6 to around 12 inches in diameter.

Propagation is by means of seed. The Florida Experiment Station has conducted budding work in an effort to accurately and rapidly propagate certain trees that bear fruit in clusters instead of singly, and consequently bear much more fruit. Seedling tung-oil trees, like seedling fruit trees, are mongrel and, while seedings bear some resemblance to the parent, growth habits of the parent tree cannot be transmitted with certainty to the seedling.

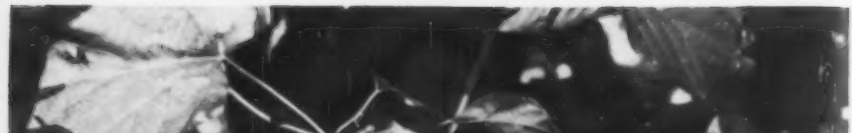
While the tung-oil tree gives excellent response to fertilizers and cultivation, it will grow on poor soils and with very little cultivation. The trees require a well drained, non-lime soil for best results. Both winter and summer cover crops to help retain and build

up the fertility of the soil have been found to give good results in tung-oil groves.

The tung-oil fruit resembles a rusty apple in outward appearance, but is divided into sections, each section containing a seed or "nut." The number of seed in a fruit varies from 5 to 15, but is most often 5. Although the seed are not true nuts, they are generally spoken of as nuts.

The fruits generally mature in October and November, and harvesting is very simple. The fruits are allowed to mature and fall to the ground, where they may be harvested at once or they may be

Young tung-oil tree in bloom in Florida



A cluster of American tung-oil fruits

allowed to remain on the ground for weeks or even months before they are gathered. When the fruits are allowed to lie for several weeks, the outer husks are easier to pull off and free the seed.

The oil in the seed is contained in little cells or sacs. When it is expressed, the meat of the seed should be moist to prevent the oil from being absorbed by the meat after it is pressed from the oil sacs.

It is possible to express tung-oil on hydraulic presses such as are used in the manufacture of peanut and cottonseed oils. In this process the meat is first run through a roller and reduced to a meal. It is then transferred to a heating or tempering apparatus, which brings it to a uniform temperature and makes the oil flow freely. It next goes to a former, which forms it into cakes, at the same time wrapping it with press cloths made from camel's hair. It is then placed in stacks with perforated plates between, 12 to 15 cakes to a stack. Pressure is then directed against the whole by a hydraulic ram. The cake remains in the press and the oil finds its way through open channels to a drain tank, where it is settled or filtered.

Fortunately, little or no color is extracted from the meats with the oil. Some oil seeds—like cotton seed—contain color cells and the color is soluble in the oil, so that it is necessary to remove the color from the crude oil by refining. Refining is not necessary in the case of tung-oil. The only thing required after pressing is to let the oil settle, and then to filter it.

Another method of extraction, called the expeller process, is more adapted for use with tung-oil seeds. In the expeller process, the seeds are cracked and fed into the expeller. The expeller is a steel cylinder built up of staves like a barrel. A shaft runs through the cylinder and on this shaft is a

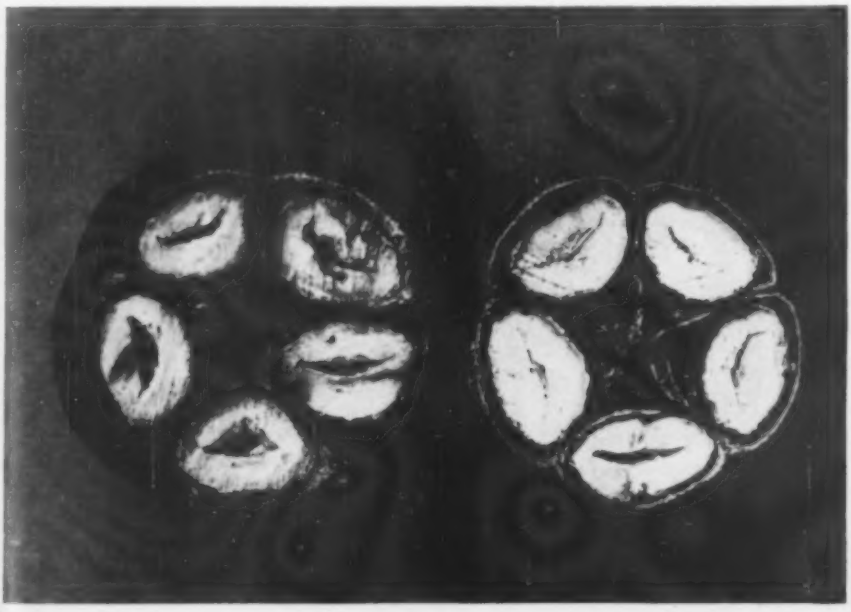
broken screw. At the far end is a cone that can be tightened as required. The tung-oil meats are forced against this cone, and the broken screw creates pressure. The oil finds its way between the staves.

In either process there is left in the residue from 5 to 7 per cent oil. It is possible to extract with solvents and reduce the oil left in the residue to as low as 1 per cent.

The pomace or residue, which is poisonous, contains some plant nutrients and is used as a fertilizer. It tests 4½ to 5 per cent ammonia and a small amount of potash and phosphorous.

The Chinese are still using extraction methods of 1,000 years standing. Their press is made of a slot about 12 inches wide and two to three feet long cut lengthwise in a log. The meats are all prepared and crushed by hand. They are heated in open pans and put into small sacks. The sacks are put in the slot in the log, each sack separated from the next by a smooth stone. Then the slot is filled and pressing is ready to commence, thick wedges are driven by hand in one end, and then thinner wedges are driven until pressure is exerted.

The oil left in the residue by this method runs from 16 to 22 percent. The Chinese leave enough oil in the residue to pay all costs of pressing by modern methods. On account of poor control in handling and heating in the Chinese method, the meats are partially or wholly overheated, resulting in a dark oil partially decomposed and running from 5 to 8 percent free acid. With American methods, a light and practically neutral oil is produced, which is much better for use in varnishes and paints. It is estimated that one American press will do the work of 100 Chinamen.



Cross section of tung-oil fruit, showing the seeds or "nuts" which contain oil

Dr. Battle's New Cup Ready for Smalley Foundation Award

MEMBERS of the American Oil Chemists' Society will be interested in seeing the new cup which has been offered for the Smalley Foundation competition by Dr. H. B. Battle, President of the Battle Laboratory. As is generally known, the Battle Laboratory of Montgomery, Alabama, won permanent possession of the first cup last year, having then received the award for the third time. As was announced in OIL & FAT INDUSTRIES for September 1926, Dr. Battle very generously offered to supply a new cup, to be awarded on the same basis as before.

The rules of the competition provide that the cup be awarded each year to the collaborator in the co-operative meal work who has the highest average efficiency in the determination of oil and ammonia, in connection with the Smalley Foundation cooperative analytical work. The winner of any single year's competition keeps possession of it for that year; but the cup becomes the permanent possession of the collaborator only when he receives it three different times.

Second Smalley Foundation cup supplied by Dr. H. B. Battle

The new cup donated by Dr. Battle is shown on this page and members will agree that it is an unusually handsome prize worthy to symbolize the best efforts of the investigators. The Society feels greatly indebted to Dr. Battle for his generosity in providing the cup, as it is certain to stimulate interest in this highly valuable work.

Paper on the Detection of Butter Substitutes

THE annual meeting of the Society of Public Analysts was held March 2. Among the papers, "Cacao Butter Substitutes and their Detection" was read by A. W. Knapp, J. E. Moss, and A. Melley, who stated that the most useful single test was the determination of the "titre" of the fatty acids, and, in the absence of certain other fats (*e.g.*, coconut oil), this test enabled the amount of Borneo talow in admixture with cacao butter to be approximately determined after reference to a curve. A new method of determination was based on the fact that the green colour of Borneo tallow was not bleached by ultra-violet light, whereas the yellow colour of cacao butter was readily bleached. A weighed quantity of the fat was exposed for six hours to the rays of a standardised quartz mercury vapour lamp, and the colour then compared with the colours of a set of standards containing definite amounts of Borneo tallow.

How Cottonseed Deteriorates Through Moisture

The Solution of This Problem Will Save Our Oil Mills Millions of Dollars Annually

By JOHN MALOWAN*
Myles Salt Company, Ltd.

ONE of the greatest difficulties of the cotton oil industry is its dependence on the quality of the raw material; neither is there a possibility of improving the seed after it has deteriorated, nor can good oil and press cake be manufactured from an off-grade seed.

The chief cause of deterioration is excess moisture, which may have been acquired in several ways. It is only seldom that the seed becomes wet after ginning, although that might happen when it is stored in places without sufficient protection against the weather; for instance, in sheds with leaky roofs or when shipped in faulty freight cars. When the farmers hold their seed at the farm with the intention of waiting for better prices, the seed only rarely are protected sufficiently against rain. And such seed, when later bought by an oil mill, usually has a high moisture content or already is deteriorated, sometimes to such a degree as to be valueless. It happens occasionally that farmers will wet the seed before delivery to increase their weight to receive more money.

But all those cases are only exceptions and a high moisture content is generally acquired in the fields before picking. When it rains before the bolls open and the seed cotton stays wet in the field for some time the seed are damaged, even when they are dry again when they are picked and no heating takes place. The oil mills rarely receive seed that are field damaged only; because, when there is much rain at cotton picking time, the seed cotton usually is still wet when picked and become more damaged during storage or transit.

The difference between field damaged seed and storage damaged seed is that the field damaged

Every year oil mills pay a huge toll to moisture; first in the way of field damaged seed, and later in seed that is damaged by storage. Because no convenient method is known for the mills to determine readily whether they receive prime seed or field damaged seed, the chance of their losing is heavy. And because field damaged seed usually is prevalent over wide areas, the risk to the mills is tremendous. Seed damaged by storage presents a similar problem: Although the damage is clearly preventable no one has yet evolved a wholly satisfactory method of avoiding it.

Here is a big problem for some one to solve.—The Editor.

* Formerly with Consumers Cotton Oil Mills, Houston, Texas.

seed still has the prime color while storage damaged seed is discolored. Both kinds of seed yield oil higher in free fatty acids than prime seed, although field damaged seed will never yield as bad an oil as will some storage damaged seed. This works to a disadvantage to the oil mills, because at present there is no way by which the mills can conveniently determine whether they receive prime seed or field damaged seed. According to the rules of the Interstate Cotton Seed Crushers Association the buyer can only deduct from the sales price for discolored seed and excess moisture, and not for high acidity even if he should know of it at the time of sale. This will result in great losses to the oil mills because conditions causing field damaged seed will extend over large areas and the oil mills will find out when too late that they paid for prime seed and received inferior seed. I have seen seasons where oil mills had to pay a claim for every car of oil shipped on account of excess refining loss although, as determined by cutting, only prime seed had been bought and crushed. Quite often the superintendent is then blamed for manufacturing bad oil from good seed. The cake will be of prime color but the acidity of the oil may run considerable over 1.50 per cent F. F. A. The oil usually is not hard to refine but the refining loss will be higher than the permitted 9 per cent. An analysis would of course reveal their real quality but such a determination is only rarely made; because, as far as I know, no method is known which would quickly determine the real quality of cottonseed. Storage damaged seed are more easily detected, because when seed heat they become discolored and the discoloration increases with the degree of damage although it is impossible to judge accurately by the color the grade of oil that can be obtained.

When damp seed are stored the temperature of the pile rises rapidly and can increase 50 to 60 degrees in a few days. There is no case known where the temperature rose to such a degree as to cause the seed to burst into flames spontaneously; but a temperature of 175 degrees has been observed by me in a car of seed received at the plant and the temperature may have even been higher before the car reached us.

The danger line for moisture is around ten per cent, but conditions will determine whether seed with that moisture will heat. When put into large piles as soon as ginned, seed will heat easier than seed that have been kept cool for several weeks and then put into piles, although the moisture content might be the same in both cases. Warm and damp weather continuing for several days may cause heating in a pile of seed which otherwise may have remained cool. A pile of seed which had remained cool for quite some time will start heating if a few tons of seed of high moisture content placed alongside of it will start heating. The same may happen if on account of a leak in the roof overhead a small portion of the pile will become sufficiently wet as to start heating; then the whole pile will become infected and heat up. A steam pipe placed too near the pile may start local heating which if not stopped in time will spread to the whole pile. Seed containing much impurities like trash, bolls, and mashed seeds will start heating with a lower moisture content than clean seed. These instances are meant for seed whose moisture content is within 10 and

12 per cent. Seed with less than 10 per cent will rarely heat and seed with more than 12 per cent moisture have to be kept cool to prevent heating.

Considering that the value of heated seed may be only half or even less than that of prime seed, depending on the degree of deterioration every oil mill will try to prevent seed from getting hot and there are several ways to obtain this result but in bad years the seed are received by the oil mills already in bad condition or the moisture content is so high that the oil mills are powerless in stopping the deterioration.

The best and safest way would be to dry the seed before storing and several seed dryers have been installed. The drying is done by blowing hot air through thin layers of seed and cooling the seed by means of cold air blasts before storing. Although such an installation is effective the investment is very high, because the capacity has to be great enough for the peak load lasting only a few weeks. And as bad seasons are fortunately rare the dryers may be idle and may not be needed for several seasons. Another disadvantage is that the lint becomes brittle on account of the high temperature during drying and the manufactured lint will be of lower grade and value. The dryer has to be watched very carefully or its value is decreased proportionately. The seed can also be dried by spreading them in thin layers and turning them over occasionally by forks. This method can only be used when the seed sheds are nearly empty as at the beginning of the season, because very much space is required. Should the weather be damp a long time will be required for this drying.

If a pile of seed begins to heat there are two ways to cool off the seed. The one way is to move the whole pile of seed by feeding into horizontal and vertical conveyors and making a new pile. The further the seed is made to travel the better, because besides cooling the seed some moisture may be lost. Another way of keeping a pile of seed cool is by blowing air through it by means of a blower. The seed bins will have to be equipped beforehand for this eventuality with air conduits permitting the air to pass uniformly through the seed. Only a few inches of air pressure are required and a six-foot blower can take care of several thousand tons of seed. It is not necessary to blow air through the seed continuously because the temperature will drop quickly as soon as the air is turned on. This method suffers from the disadvantage that the air will carry the moisture from the bottom layers to the seed at the top and there the moisture may condense or be absorbed by the seed. If the ventilation were kept up for a long time it would eventually dry out the whole pile, but rarely such great volumes of air are blown through and the humidity is usually high during the fall months.

Several years ago experiments were made to prevent heating by the addition of chemicals to the seed and the addition of small amounts of sodium chloride were found to be very effective and cheap; but the rules of the Interstate Cotton Seed Crushers Association prohibited the addition of anything to the seed to be sold as prime seed. Considering that oxygen is required in the heating, a good method of prevention would be to keep the storage bins air tight or filled with gases low in oxygen, like flue gases; but such a construction would come very high.

Besides, seed of high moisture content, if stored with exclusion of air, will putrefy and become quite valueless. The amount of heat evolved depends on the temperature and is small at a low temperature; but if sufficient to raise the temperature of the pile, the generation of heat will increase also, with the result that the temperature will rise faster and faster. If the seed house and the seed were kept at 60 to 70 degrees very little heat would be generated by the seed and very little cooling would be required to keep the seed at that temperature.

Heating of seed is caused by enzymes which require moisture to become active. It is not caused by bacteria. Seed that have been disinfected will heat as easily as seed that have not. Heating is not the natural living process of the living seed, because heated seed will have lost to a great extent or completely their power of germination. Oxidation is the most important chemical process taking place; the sugars are used up first, then the pentosans are attacked and oxidized to carbondioxide. The oils and proteins are not destroyed, but the chemical and physical characters will change. The glyzerides of the oils become hydrolized and the acidity of the oil will increase. The proteins become coagulated and insoluble in a solution of sodium chloride. The cell walls become soft and the kernel dark on account of the coloring matter which becomes oxidized and spreads through the whole kernel. The refining loss of the loss will increase not only on account of the increase in free fatty acid, but because other substances will become dissolved or suspended in the oil. The press cake will have a dark color and an off odor. A cake slightly off can be sold as stock food; but if the seed be badly damaged the cake can be sold for fertilizer only. The oil content of an off cake is higher than of prime cake because it seems that on account of the softness of the seed the oil is not so readily expelled. The time of cooking the meats has to be extended or the steam pressure raised to expel the excessive moisture.

Although great losses are sustained by the oil mills and farmers whenever there is unfavorable weather at cotton picking time very little progress has been made in reducing those losses. The person who discovers a process which will prevent the seed from heating (which process must be applied at the gins to be of great benefit) will become a great benefactor of the cotton oil industry directly and the lard compound, the oleomargarine, and the stock food industry indirectly. A quick and simple method of determining the value of cottonseed when bought would undoubtedly take much of the gamble out of the cotton oil industry that now is prevalent.

A Correction

An advertisement appeared in OIL & FAT INDUSTRIES for April, featuring Dr. Edson's book "The Chemistry & Examination of Edible Oils & Fats. Their Substitutes and Adulterants." The price of this book was announced as being $20.00. The correct price should be $12.50. The publishers of the Journal put it highly important to correct this error, lest the price formerly announced deter anyone from ordering as valuable a book as this.

The Chemical Composition of Cottonseed Oil From the Upland Type of Seed

By GEORGE S. JAMIESON and WALTER F. BAUGHMAN

AN investigation of the composition of the oil expressed from the Sea Island type (long fiber) cottonseed grown in Louisiana during the 1919 season has been previously reported[1]. Recently the composition of the oil expressed from the Upland type (short fiber) has been determined in order to compare the composition of the oils contained in the seeds from these two types of cotton. The oil from the Upland seed grown in Mississippi during the 1926 season was expressed hot in the laboratory by an oil expeller.

Chemical and Physical Characteristics

The oil was refined according to the official method of the Interstate Cottonseed Crushers' Association. The more important chemical and physical characteristics of the crude and refined oil are recorded in Table I. The percentages of saturated and unsaturated acids were determined by the lead salt-ether method[2] and corrections were made for the small quantity of unsaturated acids that contaminated the saturated acid fraction. The percentage of neutral oil in the crude as determined by the Wesson method[3] was 96.41.

TABLE I. UPLAND TYPE COTTONSEED OIL. CHEMICAL AND PHYSICAL CHARACTERISTICS

	Crude Oil	Refined Oil
Specific gravity 25°/25°	0.9230	0.9174
Refractive index, 20°	1.4745	1.4725
Acid value	2.9	0.1
Iodine number (Hanus)	106.8	108.2
Saponification value	199.3	195.0
Unsaponifiable matter (%)	.....	0.9
Saturated acids as determined (%)	.....	24.1*
Unsaturated acids as determined	.....	71.2
Iodine number of unsaturated acids	.....	144.4
Saturated acids (corrected) (%)	.....	23.3
Unsaturated acids (corrected) (%)	.....	72.0

* Iodine number 4.7.

Unsaturated Acids

It was shown in the Sea Island oil investigation that the unsaturated acids fraction of cottonseed oil consists of oleic and linolic acids, and that linolenic acid is not present. The percentage composition of the unsaturated acids of the Upland oil was calculated from the theoretical iodine numbers of oleic acid (90.1) and linolic acid (181.4) and the determined iodine number of the unsaturated acids fraction (144.4), with the following results:

	Per cent	In original oil Per cent	Glycerides in original oil Per cent
Oleic acid	40.53	29.18	30.5
Linolic acid	59.47	42.82	44.8
	100.00	72.00	75.3

Saturated Acids

A quantity of the saturated acids, prepared by the lead salt-ether method, was esterified with methyl alcohol. The mixture of methyl esters was fractionally distilled under diminished pressure. The data for the distillation are

[1] J. Am. Chem. Soc., *42*, 1197 (1920).

[2] J. Am. Chem. Soc., *42*, 2398 (1920); Cotton Oil Press, *6*, 1, 41 (1922).

[3] Jamieson and Baughman, Cotton Oil Press, *6*, 4, *33* (1922); Wesson, J. Oil and Fat Ind., *3*, 297 and 343 (1926).

TABLE 3. Upland Type Cottonseed Oil. Results of Analyses of Fractions Obtained by Distilling Methyl Esters of Saturated Acids

Fraction	Iodine Number	Saponification Value	Mean Molecular Weight	Esters of Unsaturated Acids Percent	Esters of Saturated Acids Mean Molecular Weight	Myristic Acid Percent	Myristic Acid Grams	Palmitic Acid Percent	Palmitic Acid Grams	Stearic Acid Percent	Stearic Acid Grams	Arachidic Acid Percent	Arachidic Acid Grams
1	0.8	211.7	265.0	0.58	264.9	18.34	1.52	75.82	6.29	.....	.....	.....	....
2	1.5	208.1	269.6	1.09	269.3	2.70	1.21	90.12	40.37	.....	.....	.....	....
3	3.2	207.1	270.9	2.33	270.3	.....	....	92.61	43.11	.....	.....	.....	....
4	6.3	204.7	274.1	4.58	273.1	.....	....	81.75	18.07	8.77	1.94	.....	....
5	15.9	199.1	281.8	11.56	280.2	.....	....	54.51	7.69	29.50	4.16	.....	....
6	17.1	186.3	301.2	12.44	301.9	.....	....	.....	.....	73.02	3.91	10.47	0.56
							2.73		115.53		10.01		0.56

given in Table 2. The preliminary distillation was made from a 1-litter Claissen flask and resulted in seven fractions designated by the letters A to G and a residue. The preliminary fractions were redistilled as indicated in the table and six fractions and a small residue obtained.

The iodine numbers which are measures of the contaminating unsaturated acids and the saponification values of the final fractions are given in Columns 2 and 3 of Table 3. From these data the mean molecular weight of the saturated acids esters in each fraction was calculated as explained in the report of the Sea Island oil investigation and the results are recorded in Column 6.

TABLE 2. UPLAND TYPE COTTONSEED OIL. FRACTIONAL DISTILLATION OF METHYL ESTERS OF SATURATED ACIDS

(141.9 g. subjected to distillation)

Fraction		Temperature °C.	Weight g.
Preliminary Distillation at 6 mm. pressure			
	A	168-9	21.15
	B	170-1	22.50
	C	171	22.00
	D	171	22.45
	E	171-2	22.60
	F	172-7	20.65
	G	177-84	6.72
	Residue		3.85
Final Distillation at 2 mm. pressure			
Fractions A and B added	1	149-54	8.30
Fractions C and D added	2	154-6	44.80
Fractions E and F added	3	156-61	46.55
	4	161-4	22.10
Fractions G and residue added	5	165-75	14.10
	6	176-210	5.36
	Residue		0.26

These results indicate what saturated acid esters may be present in the fractions. The mean molecular weights of the saturated acid esters in Fractions 1 and 2 lie between the molecular weights of methyl myristate (242.3) and methyl palmitate (270.3) and suggest therefore that these two fractions contain these two esters. The result for Fraction 3 indicates that methyl palmitate is the only

saturated acid ester present in this fraction. The indicated constituents for Fractions 4 and 5 are methyl palmitate and methyl stearate (298.4) and for Fraction 6 methyl stearate and methyl arachidate (326.4).

In order to test the correctness of these deductions the free fatty acids were recovered from some of these fractions and the constituent saturated acids isolated by fractional crystallization from alcohol. Their identities were established by the melting points and by observing whether or not these melting points were lowered when the substances were mixed with equal quantities of the respective pure acids which they were suspected of being. By this method pure myristic and palmitic acids were isolated from Fraction 1, pure stearic acid from Fraction 5 and pure arachidic acid from Fraction 6.

The quantities present in the various fractions were calculated from the mean molecular weights of the saturated acid esters (Column 6 Table 3) and the theoretical molecular weights of the esters. The results are given in Columns 7-14, Table 3.

In Table 4, the percentage composition of the saturated acids is given in Column 2, the percentages of the various acids in the original oil in Column 3, and the equivalent percentages of glycerides in Column 4.

TABLE 4. UPLAND TYPE COTTONSEED OIL, SATURATED ACIDS

	Acids in Saturated Acid Fraction		Acids in Original Oil	Glycerides in Original Oil
Acid	Grams	Per cent	Per cent	Per cent
Myristic..	2.73	2.12	0.49	0.5
Palmitic..	115.53	89.68	20.90	21.9
Stearic...	10.01	7.77	1.81	1.9
Arachidic.	0.56	0.43	0.10	0.1
	128.83	100.00	23.30	24.4

Summary

A study has been made of the composition of a sample of Upland type (short fiber) cottonseed oil and the results are given below. For comparison the composition of a sample of Sea Island type (long fiber) cottonseed oil is also given.

Glycerides of	Upland Type Cotton-seed Oil	Sea Island Type Cotton-seed Oil
Oleic acid	30.5	35.2
Linolic acid	44.8	41.7
Myristic acid	0.5	0.3
Palmitic acid	21.9	20.0
Stearic acid	1.9	2.0
Arachidic acid	0.1	0.6
Unsaponifiable matter	0.5	...

OIL, FAT AND WAX LABORATORY
Bureau of Chemistry
U. S. Department of Agriculture
Washington, D. C.

American Oil Chemists Society Announces Program for Annual Meeting

THE Eighteenth Annual Meeting of the American Oil Chemists' Society will be held on May 9th and 10th, for the ninth time, in New Orleans, La., at the Roosevelt Hotel. The thirty-first convention of the Interstate Cotton Seed Crushers' Association for the Twelfth time will also meet in New Orleans immediately following, on May 11th and 12th, and 13th.

One and one-half rate fare have been secured on Special Certificate plan. Certificates must be obtained when buying ticket, and validated at New Orleans before the reduction in the return ticket will be allowed.

Associate Members of the Society are earnestly invited to attend the meeting. They will have a cordial reception from the entire membership. A special part of the program is reserved for them in which to present any new process, apparatus, materials or machinery.

Visitors and guest are also cordially invited. Wives of members and their friends will have a special welcome, and a Local ladies' committee will look after their convenience. Many historic places and buildings are especially interesting, and the beauty of New Orleans is proverbial at this time of the year. Chemists and others interested in the work of the Society will also be cordially welcomed.

The Roosevelt Hotel will be headquarters. Reservations should be made early. Other hotels near by are the St. Charles, Bienville, De Soto, and Monteleone.

The Governing Committee has been called to meet at 2 p. m. Sunday, May 8th, at the Roosevelt Hotel. Matters for the attention of the Committee should be in the hands of the Secretary before that time.

Members and visitors are requested to register early, and secure badges and make banquet reservations. This is necessary for the information of the local committee.

The Annual Banquet will be, as usual, a special feature of the Convention, and is a fitting finale to the meeting. The banquet will be held Tuesday evening, May 10, the hour and place to be announced later. Tickets must be secured on arrival, at time of registration.

The Program in Detail

MONDAY, MAY 9th.

Convention called to order 9:30 a. m.
Invocation
Reading of Minutes of last meeting.
Address of President ..... R. H. FASH
Report of Secretary-Treasurer ..... J. C. P. HELM
Report of Governing Committee ..... R. H. FASH
Report of Membership Committee ..... H. P. TREVITHICK
Paper, *"The Application of Modern Analytical Methods to Transactions in Cottonseed Products"* ..... DAVID WESSON
Report of Detergents Committee ..... L. F. HOYT

Paper, *"Winterizing"* ..... FRANCIS M. TURNER
Report of Neutral Oil Committee ..... CLAUDE E. McLEAN
Paper, *"Solvent Extraction Experiences in Foreign Lands"* ... BRUNO HASSEL
Report of Committee on Awards ..... DAVID WESSON
Report of Moisture Committee ..... W. H. IRWIN
Paper, *"A Few Facts Concerning Deordorization"* ..... JOHN L. HUTTON
Report of Analysis of Commercial Oil and Fats Committee . W. D. RICHARDSON
Report of Basic Research Committee ..... E. R. BARROW
Report of Referee Board ..... DAVID WESSON
Report of Planning Committee ..... H. J. MORRISON
Our Associate Members—Introductions and Remarks
Appointment of Special Committees and Miscellaneous
(Afternoon Sessions, if necessary, at 2:30 p. m.)

TUESDAY, MAY 10th

Meeting called to order 9:30 a. m.
Report of Cake Color Committee ..... R. K. BRODIE
Paper, *"New Investigations Upon the Chemistry of Gossypol"* .... E. P. CLARK

REFINING SYMPOSIUM

Paper, *"The Fundamental Principles of Colorimetry"* ..... IRWIN G. PRIEST
Report of Color Committee ..... H. P. TREVITHICK
Paper, *"What Is a Refined Oil?"* ..... HERMAN ASPEGREN
Paper, *"Nature of the Various Constituents to Be Removed in Refining"* ..... G. S. JAMIESON
Paper, *"Fundamental Principles of Refining"* ..... C. B. CLUFF
Paper, *"Requirements of a Refining Method From the Standpoint of a Commercial Chemist"* ..... T. C. LAW
Paper, *"Standardizing the Lovibond Glasses"* ..... IRWIN G. PRIEST
Report on Cooperative Free Fatty Acid Tests ..... C. B. CLUFF
Report of Refining Committee ..... C. B. CLUFF
Paper, *"A Rapid Method for Determining Neutral Fat in Soap"* ... L. F. HOYT
Report of Seed Committee ..... R. K. BRODIE
Report of Uniform Methods Committee ..... FELIX PAQUIN
Report of Smalley Foundation Committee ..... H. C. MOORE
Report of Special Committees
Miscellaneous Business
General Resolutions
Announcements
Election of Officers
Installation Ceremonies
Adjournment

Valuable Oil, Fat and Wax Bulletin Just Off the Press

THE United States Department of Agriculture has just published Department Bulletin No. 1475, entitled "Production and Utilization of Fats, Fatty Oils, and Waxes in the United States." This is the work of Dr. George S. Jamieson, Chemist in charge of the Oil, Fat and Wax Laboratory of the Department. Dr. Jamieson is a member of the American Oil Chemists' Society, an Associate Editor of Oil & Fat Industries, and one of the leading scientists in this branch of his profession.

Bulletin 1475 is a revision of and supersedes Bulletin 769. First it takes up the Vegetable Oils, after which come the animal Fats and Oils, the Fish Oils, Fish Liver Oils, and the Waxes. The concluding pages are devoted to statistics of production and consumption of fats and oils from 1921 to 1925 inclusive.

The Consumption of Butter and Oleomargarine From 1917 to 1926

By FREDERICK E. CROXTON

Columbia University

IN 1926 the people of the United States consumed over 2,000,000,000 pounds of butter and more than 242,000,000 pounds of oleomargarine. At an average price per pound of $.531 for butter and $.304 for oleomargarine the value at retail of the butter consumed was about $1,060,000,000 and of the oleomargarine about $73,500,000.

Data of the monthly consumption of butter and oleomargarine from January 1917 are shown in graphic form in Chart 1. In spite of a slight fall from 1917 to 1918 the curve of butter consumption evinces a marked tendency to rise. The total amount of butter consumed has been greater each year from 1918 to date. Approximately 1,486,000,000 pounds of butter were used in the United States in 1918 (see accompanying table). Eight years later, in 1926, a growth of over 500,000,000 pounds or about 35 per cent had taken place. In 1926 over 2,000,000,000 pounds of butter were consumed, or more than 17 pounds for each inhabitant of the United States. The curve of oleomargarine consumption (Chart 1) showed a sharp drop in 1921 and 1922. Since 1922 it has been slowly rising. In 1917 about 298,000,000 pounds of oleomargarine were consumed. This figure rose to 360,000,000 in 1920 but dropped to 210,000,000 in 1921 and 180,000,000 in 1922. By 1926 the annual consumption had risen to approximately 243,000,000 pounds which represented slightly over 2 pounds of oleomargarine per person in the United States. Of course, one must not visualize each and every man, woman, and child in the nation as consuming two pounds of oleomargarine. There are many rural sections of the country in

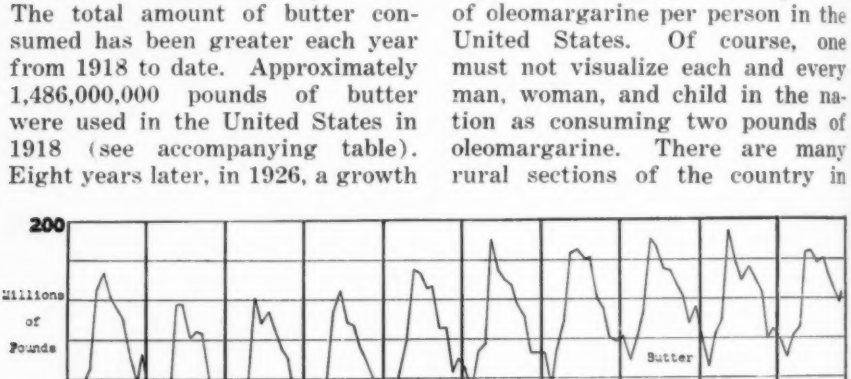


Chart 1—Monthly Consumption of Butter and Oleomargarine 1917-1926

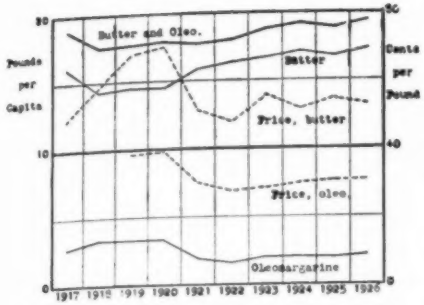


Chart 2—Annual Per Capita Consumption and Average Annual Retail Price of Butter and Oleomargarine, 1917-1926. (*Retail price of oleomargarine not available for* 1917 *and* 1918.)

which oleomargarine is an unheard of commodity. On the other hand the United States Bureau of Labor informs us, "In many cities there is as much oleomargarine as butter used."

In order to eliminate the factor of population growth as influencing the consumption of butter and oleomargarine Chart 2 presents curves of the per capita annual consumption of butter, olemargarine, and of butter and olemargarine combined from 1917 to 1926. In addition, the retail price of butter is shown from 1917 and of oleomargarine from 1919. The curves of consumption show (1) a drop in the per capita oleomargarine consumption in 1921 and 1922, a rise in 1923, a steadying tendency through 1925, and a slight rise in 1926, (2) a general increase, since 1918, in the amount of butter used per person in the United States, and (3) since eight or nine times as many pounds of butter as oleomargarine are used the curve of the per capita consumption of butter and oleomargarine combined reflects largely the movements of the curve of per capita consumption of butter, and here again there is evident a gradual rise in the amount consumed per person since 1918.

If the curves of per capita consumption and price in Chart 2 be compared it is apparent that, in general, when there is an increase in the price of butter there is a decrease in the per capita consumption of butter and when there is a decrease in the price of butter there is an increase in the per capita consumption of butter. It is also seen that the per capita consumption of oleomargarine tends to increase when the price of butter increases and to decrease when the price of butter decreases. The changes in the per capita consumption of oleomargarine are, of course, not so much responses to its own price (which does not fluctuate widely) as responses to fluctuations in the price of butter.

The nature of oleomargarine as a substitute for butter is shown clearly in Charts 1 and 2. In Chart 1 when the consumption of butter rises that of oleomargarine usually falls and when the consumption of butter falls that of oleomargarine usually rises. The same holds true of the per capita consumption of the two commodities shown in Chart 2. Chart 3

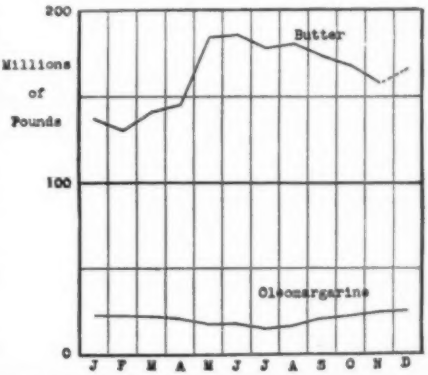


Chart 3—Seasonal Movements of Consumption of Butter and Oleomargarine as Shown by Data for 1926.

Total Consumption and Per Capita Consumption (in pounds) of Butter and Oleomargarine, 1917-1926

Year	Total consumption		Per capita consumption	
	Butter	Oleomargarine	Butter	Oleomargarine
1917.....	1,657,303,000	297,593,000	16.05	2.88
1918.....	1,485,553,000	350,551,000	14.23	3.36
1919.....	1,522,128,000	350,239,000	14.50	3.34
1920.....	1,553,590,000	359,966,000	14.60	3.38
1921.....	1,725,733,000	210,210,000	15.92	1.94
1922.....	1,796,053,000	179,628,000	16.37	1.64
1923.....	1,866,770,000	226,461,000	16.75	2.03
1924.....	1,934,102,000	229,872,000	17.05	2.03
1925.....	1,942,106,000	232,303,000	16.88	2.02
1926.....	2,009,953,000	242,710,000	17.27	2.09

emphasizes the seasonal movements of the consumption of butter and oleomargarine, showing the consumption for each month of 1926. In the case of butter, maximum consumption usually occurs in May and June with minimum consumption in January and February. If the data of monthly consumption be adjusted for the number of days in each month (if, for example, each month be reduced to a 30 day basis) February is no longer the low month, but assumes its place about midway between January and March, and November consumption becomes more nearly the same as that of October and December. The December 1926 figure, shown by dotted lines on Charts 1 and 3, represents the writer's estimate (166,000,000 pounds) of the consumption of butter for that month. In the case of oleomargarine, maximum consumption usually occurs in the first or last months of the year and minimum consumption in the summer. Here again the increases and decreases in the consumption of butter and oleomargarine move in opposite directions.

(Reprinted with permission from the *American Food Journal*, March, 1926.)

Dr. Schwartze to Conduct Research at Mellon Institute

DR. Edward R. Weidlein, director, Mellon Institute of Industrial Research, University of Pittsburgh, has announced the appointment of Dr. Erich W. Schwartze to the senior incumbency of the Institute's Multiple Industrial Fellowship on Cooking Utensils. Dr. Schwartze is well known scientifically because of his published contributions to the literature of the chemistry and pharmacology of cottonseed, peanut oil, and of metals, especially tin and cadmium, used in the construction of food containers.

This Fellowship has been recently established for the purpose of making a comprehensive chemical and pharmacodynamic study of the effects of the corrosion of metallic cooking utensils during the preparation of foods therein. The investigation will cover the effect upon the animal body of the metal taken up by and ingested with the cooked food as well as the effect of the material of the utensil upon the food constituents, particularly the vitamins, during culinary, food-manufacturing and sterilizing operations. The reseaches will be conducted along scientific lines.

Changes in Olive Oil After Long Standing

By R. O. BROOKS, B. Sc.

OLIVE oil, although the best known and most desirable edible oil, is, unfortunately, one of the oils most subject to oxidation and other changes which develop rancidity. The principal factor is oxygen; indeed it has been said that without oxygen there can be no rancidity. However, other factors, such as light, heat, moisture and contact with metals, serve to accelerate the oxidation. The chemical reactions involved are rather complex and some of the products formed have a very disagreeable taste or odor, while others do not seem to be responsible for the effects known under the term "rancidity."

In earlier years it was supposed that the principal changes consisted of the slow liberation of free fatty acids from the glycerol esters constituting the oil, due to a fat-splitting ferment or enzyme (olease or lipase) naturally present or formed by bacteria allowed to get in during careless manufacture; and subsequently the oxidation of the free fatty acid to oxyacids having disagreeable taste, etc. Oleic acid is the principal fatty acid (combined with glycerol as an ester and called "olein" or "triolein") in olive oil and being an "unsaturated" acid capable of uniting directly with iodine (hence the analytical item known as "Iodine absorption" or "Iodine No.") and other elements, it takes up oxygen readily. Oleic acid when fresh is white, tasteless and odorless, but quickly becomes yellow in color and acquires a rancid odor from oxidation. Thus the present commercial practice of requiring a very low content of free fatty acid in edible oil is well founded, as it stands to reason that the less free acid there is present to start with the less rancidity there will be when ageing has enabled oxidizing changes to take place. It must be remembered, however, that the proportion of free fatty acid can in time increase, due to the aforementioned ferment or enzyme naturally present and especially that formed by bacteria present as the result of careless manufacturing methods.

The per cent of free fatty acid if not a measure of rancidity, as freshly liberated oleic acid is not rancid (as said above) and, if the oil is well protected from oxidation, an oil with a 1 per cent free fatty acid content can remain "sweet" while a carelessly protected oil with only 0.5 per cent acidity may become quite objectionable. However, on general principles, the less free fatty acid there is present the better. More recently it has been determined that other compounds than the oxidized free fatty acid are formed by the combined effects of oxygen, light, moisture, etc., some of which are also disagreeable tasting and smelling substances. Various aldehydes, ketones and acids of less molecular weight than the fatty acids originally present, are formed and appear to be constant constituents of fats and fatty oils which have stood too long under unfavorable conditions and become rancid. Most of the various color-forming tests used for the detection of incipient or masked rancidity ("Kreis rancidity test," for instance) depend on the presence of several or all of these

The Spice Mill. P. 574, March, 1927

various constituents resulting from oxidation changes, and it is to the effect of all of them, including the oxidized free fatty acid, that the characteristic odor and taste of rancid fats and oils are due.

The development of rancidity in a carefully manufactured and properly stored olive or other edible oil is very slow, especially if the per cent of free fatty acid be low to start with. In a grocery store where turnover of stock is frequent, a good olive oil, even though stored in glass and exposed to light on a shelf, will test normal and show no very objectionable rancidity. In sealed tin cans it will keep "sweet" for a relatively long time. However, there are stores in certain sections where olive oil is infrequently asked for and a small batch of bottles may stand exposed to light for a year or so, or one or two bottles may be shoved in back of a new shipment or otherwise get displaced so as to stand many years. There is always an air space in the neck of each bottle, one-fifth of which is oxygen; moreover, there is more or less dissolved air and oxygen in the oil and for the small amount of oxidation necessary to render an oil rancid and to make it analyze abnormally in time this is sufficient.

How abnormal an old olive oil sample can analyze will be illustrated below with data on a pure oil, originally normal in every way and of very excellent quality, with a very low content of free fatty acid to start with. An oil showing less change than this particular oil would be found to analyze so abnormal as to lead to the charge of adulteration unless the official chemist studied into the matter very thoroughly.

The oil in question was one of the first commercial olive oils produced in California, being carefully pressed from selected olives grown on the Windermere Ranch of Mr. Andrew McNally at La Mirada, Cal., and sold through their Eastern office in the Rand, McNally Building in Chicago. The writer was called upon to analyze this oil in the Fall of 1906 and found it to be a pure, very high grade olive oil, testing as given below. On account of its being the first California olive oil which the writer had knowingly tested and because of the rather attractive bottle, it was allowed to stand year after year on an exhibition sample shelf to the present day (1927), being kept corked, but exposed indirect to light and room temperature meanwhile. It was analyzed a second time in 1916 and more recently in 1926 as follows:

In 1916 an official analysis would have resulted in this oil being declared "adulterated," in fact, probably at the end of five years the regular data would have been found to be suspiciously abnormal. The lowering of the iodine absorption value is due, no doubt, to the satisfaction by oxygen of the nor-

(*Continued on page* 150)

	1906	1916	1926
Odor and taste	No rancidity	Very rancid	Extremely rancid
Kreis rancidity test	.....	Positive	Very strong
Specific gravity (15.5° C)	0.9132	0.9254	0.9383
Iodine absorption No.	83.60	75.26	68.58
Saponification No.	190.80	199.60	213.20
Acid No. (from per cent free acid)	0.96	8.04	15.68
Ester No. (Sap. No.—Acid No.)	189.84	191.56	197.52
Free fatty acids (of oleic)	0.48%	4.02	7.84%

Papers on Vegetable Oils Are Read Before the American Chemical Society

AT the annual spring meeting of the American Chemical Society, at Richmond, Va., held the week of April 11, several papers were read in which the oil chemists will be interested. Dr. E. P. Clark, who is conducting basic chemical research into cottonseed products for the Interstate Cottonseed Crushers Association, read a preliminary report of new investigations upon the Chemistry of Gossypol. An abstract of Dr. Clark's paper prepared by the Society states:

"As is well known, the feeding to stock of cottonseed or excessive amounts of cottonseed meal produces a syndrome which if the feeding is continued terminates fatally. According to Carruth and to Schwartze and others, the principle responsible for this toxic effect is gossypol. However, in cottonseed meal very little free gossypol is present, but a substance 'd' gossypol can be obtained as an aniline derivative by hot aniline extraction. It has been suggested that this 'd' gossypol may be an oxidation, reduction or hydrolytic product of gossypol which is physiologically inert. The chemistry of gossypol and 'd' gossypol is practically unknown. Marchlewski suggested the formulas $C_{13}H_{14}O_4$, or $C_{32}H_{34}O_{10}$, while Carruth suggested $C_{29}H_{28}O_9$ or $C_{30}H_{30}O_9$ and further states that possibly it is a condensation product of two molecules of a flavone. The preliminary report upon this subject now being made pertains to the nature of the gossypol molecule and to the identity of the two substances 'aniline gossypol' and 'aniline' 'd' 'gossypol' with a suggestion as to the cause of the diminution of toxicity due to the cooking and pressing process used in the manufacture of cottonseed oil. As to the nature of gossypol, it has now been found that it is a nitrogenous body in which the nitrogen is undoubtedly present in ring formation."

* * *

Other papers were read before the Biological Chemistry Division, which have been abstracted follow:

The present status of the so-called cottonseed meal injury. By J. O. Halverson.

Two views have come to be held in regard to the injury caused by the heavy feeding of cottonseed meal. Since the isolation of a toxic substance, gossypol, from the seed of the cotton plant, by Withers and Carruth, one view holds that this toxic substance is the cause of this injury, thus causing cottonseed meal poisoning. Another view, since the discovery of the deficiency diseases, holds that the excessive feeding of the meal from the seed of the cotton plant may cause effects which may be due to nutritive deficiencies in the ration. Such deficiencies in a ration high in cottonseed meal may cause symptoms similar to those of gossypol poisoning. McGowan and Crichton have recently shown this on pigs.

* * *

Studies on gossypol: The elimination of d-gossypol from cottonseed meal. By F. W. Sherwood.

The results reported in this paper show that under proper conditions, and in the presence of ferrous sulfate, 90 per cent or more

of the d-gossypol in cottonseed meal can be destroyed. They further show that when cottonseed meal is heated to 125° C. in an autoclave the addition of an iron salt is unnecessary, water alone being sufficient to destroy the d-gossypol. With the lot of cottonseed meal used in these experiments 90 per cent or more of the d-gossypol present was destroyed by heating the dry meal to 125° C. for one hour in an atmosphere of steam. In 19 other samples of cottonseed meal the amount of d-gossypol destroyed varied from 36 to 76 per cent, with an average of 53 per cent of that originally present, when they were heated in an autoclave to 125° C. for one hour.

To Vitaminize Oleomargerines?

SCIENTISTS here and in Europe, more or less collaborating on the problem, have come to the same conclusion, according to Dr. Alfred F. Hess, of the College of Physicians and Surgeons at Columbia University, that the anti-rachitic vitamin D. is formed when certain sterols, a group of substances similar to fats, widely distributed in the lower plants, are exposed to ultra-violet light. Both Dr. Hess and Drs. O. Rosenheim and T. A. Webster, of the National Institute for Medical Research in London, have collaborated with Professor A. Windaus, of Göttingen University, in Germany, who has been engaged in research on the chemical problems involved in the isolation of the anti-rachitic vitamin for years.

About two years ago, Dr. Hess reported that cholesterol, occurring in all animal fats and oils, and its counterpart, phytosterol in vegetable foods, after irradiation with ultra-violet light, was the substance actually responsible for preventing rickets. Irradiated cholesterol in very much smaller doses would produce the same results as cod liver oil, only one millionth of a gram being necessary to protect a rat.

Now, however, another step in the pursuit of the vitamin has been accomplished. The English workers, Dr. Hess and Professor Windaus, of Göttingen, all believe that it is only a small portion of the cholesterol which is activated by ultra-violet light. This is an allied substance called ergosterol. This compound is widely distributed in lower plant forms and only very minute quantities are needed to protect laboratory animals from rickets.

"It was found," says Dr. Hess, "to bring about a healing process of the bones when even as little as .0003 mg. per capita daily was given. In tests in which irradiated cholesterol is fed, it has been found that approximately 1 mg. is needed to initiate healing. Other experiments will be undertaken to ascertain the relationship of ergosterol to cholesterol and the extent of its distribution in the body."

The practical value of the discovery of this concentrated form lies in the fact that it will be possible now to dispense with the cod liver oil. Hitherto it has been the practice to resort to such general remedies as sunlight and a diet of foods known to contain anti-rachitic elements. A German authority has suggested that one of the consequences of this research will be to put oleomargarine products on an equal basis with butter and cream.

New Aspects of the Chemistry of the Oils and Fats

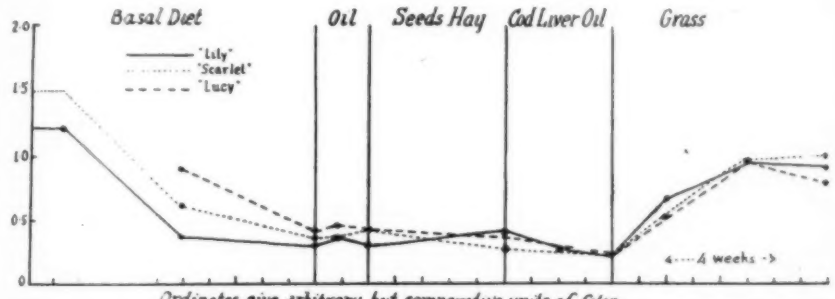
By PROF. J. C. DRUMMOND, D.Sc.

THE title of this paper is misleading, because I propose to interpret the word "fat" in its wider sense, as meaning the natural occurring product from plant and animal sources and then focus attention on those substances which have been sadly neglected by the chemist which were noted by Chevreul to resist the action of alkalies.

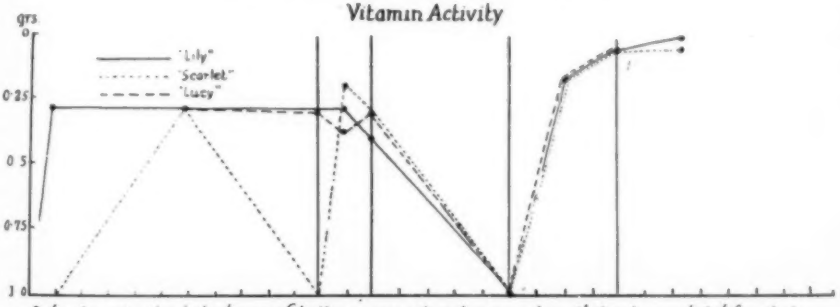
Most of the common fats contain 98 to 99% of glycerides and, in addition, certain other substances. Of these, some, such as esters of the high alcohols, cholesterol, etc., are saponifiable while others are not affected by alkalies. Complete saponification of the fats and subsequent extraction of the soap solutions by a suitable solvent removes a fraction, which we term "unsaponifiable" matter, which has been little studied by the chemist in the past beyond the quantity present, while the physiologist has formerly concentrated his attention on the digestion, absorption, and biological degradation of the glycerides.

The bio-chemist will find in the unsaponifiable matter a true El Dorado for research.

Thudichum was the first to examine various pigments such as occur in butter, egg fat and palm oil, and in 1869, published a paper wherein he termed them "Luteins."



Ordinates give arbitrary but comparative units of Color



Ordinates give the daily dosage of butter necessary to restore normal growth to rats on a diet deficient in vitamin A

He showed one of these pigments to be identical with that found in the root of the carrot, now known as "Carotene."

Willstatter and his colleagues isolated a number of these pigments which are as follows:

Pigment	Formula	Chief Sources
Carotene	$C_{40}H_{56}$	Green leaves, carrots
Xanthophyll*	$C_{40}H_{56}O_2$	Green leaves
Lycopin	$C_{40}H_{56}$	Tomato
Fucoxanthin	$C_{40}H_{56}O_6$	Brown seaweeds

* It is believed that a number of isomeric xanthophylls exist. They have not yet been separated from each other in crystalline form, but on the evidence of the spectroscope their existence is suspected.

The first two are found widely distributed in the plant world. In all cases, they are readily oxidized. For this reason, great care must be taken to separate them. They are found in several animal products, such as butter, fat, most body fats, and the yolk of many types of egg.

It is generally known that milk from the herd of cattle from pasture in summer if the crop is growing well will have a richer color than when the animals are brought into the stalls in winter, especially when deprived of green foods.

Professor L. S. Palmer of the University of Minnesota, found that the natural coloring matter of butter and egg yolks are derived from fat soluble pigments of the food.

During the digestion of foods containing the lipochromes, as these pigments are called, tend naturally to be absorbed in association with the fats and tend to follow them during transport and storage in the animal body.

The notable exception is in the case of the pig, whose fat never shows any appreciable yellow color.

It is only natural that in the process of storing fat for forming milk fats or egg yolks that some of the pigments of the food will be deposited along with them.

In these experiments the cows were brought into stall from the meadows and were fed on a ration, typical of many winter farm diets, consisting of wheat and maize gluten as concentrates, mangolds, and well-cured hay. Such a ration is very poor in lipochrome pigments and, as you will observe, the color of the butter soon diminished, only rising again in intensity when the animals were once again turned out to grass.

The association of the yellow coloring matters with butter fat may, in a sense, therefore be regarded as accidental, and it may be imitated by the experiments which have led to the production of these rather startling eggs (which were exhibited). The birds that laid these eggs were maintained on a ration deficient in the natural fat-soluble pigments until the marked yellow color of the yolks at the commencement of the experiment had completely disappeared. As soon as they were laying eggs with almost colorless yolks some fatty material deeply pigmented with the fat-soluble dyes Sudan III and Nile Blue were mixed with their food. The absorption of the dyes and their deposition in the yolk followed, I think, from purely physical causes, such as their partition between oil and water phases. These experiments leave unanswered the main question I wished to raise, namely, what is the significance of the lipochromes in the organism? It is true that the white-yolked eggs I have shown you may be fertile, and on incubation produce healthy chicks, incidentally with white and not yellow downy feathers, but in spite of this, and the considerable amount

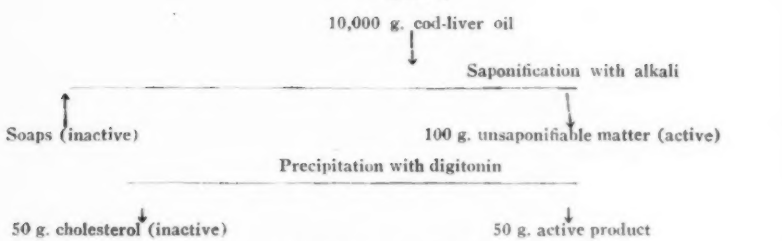
of evidence that the presence of the pigments is accidental, one feels some reluctance in abandoning the view that Nature, in most respects a strict economist, has colored an egg yolk yellow for a definite purpose. In the green plant there seems no question but that the pigments play an important part in the chemical changes that occur in the chloroplast. The very relationship that exists between the formula of the hydrocarbon carotene, $C_{40}H_{56}$, and that of xanthophyll, $C_{40}H_{56}O_2$, suggests at once to the mind of a chemist an oxidation-reduction system capable of functioning in an oily phase. In spite of much speculation, however, little is yet known of their function in the plant, and nothing whatever of their possible significance in the animal.

A short time ago there was no little excitement in biochemical circles because Prof. Steenbock, in America, traced a most remarkable parallel between the occurrence of the lipochromes and that of the vitamin A; green leaves, carrots, yellow maize, yellow butter, many other food products, all seemed to show a vitamin potency that could be correlated with their degree of pigmentation. The attractive idea that one of the pigments might actually be the vitamin seemed too good to be true, and it was, unfortunately, disproved by tests of the pure substances on animals. It is doubtful, therefore, whether the association is of more significance than physical causes; *e.g.*, similar solubilities, would account for. Thus, for example, the administration of cod-liver oil, itself poor in lipochromes, but rich in vitamin A, raised the food value of the butter fat of the experimental cows without appreciably affecting the color.

Let me now turn to the fat-soluble vitamins themselves, because they are amongst the most important of the constituents of the unsaponifiable matter of the fats in which they are naturally present. The beneficial influence of cod-liver oil in the treatment of wasting diseases, general malnutrition, and rickets, is, of course, familiar. At one time its action was believed to be due to the small traces of iodine that are frequently found in the oil, particularly in the cruder, dark varieties. Another theory, also widely held at one time, attributed the nutritious qualities to the peculiar nature of the unsaturated fatty acids which it contains, and which, it was held, would be more readily assimilated by the enfeebled organism than those which occur in most other fats.

Both theories have been to a large extent rendered untenable by the discovery that the influence of growth and bone formation of the oil itself may be exerted in exactly equivalent amount by the material that can be extracted from the soaps after saponification, provided care is taken during the process to minimize the chances of oxidation occurring. The physiologically active fraction is a yellow crystalline waxy product, representing just under 1 per cent of the original oil, and is devoid of iodine. The 1 per cent unsaponifiable fraction from cod-liver oil has formed the basis of a number of attempts to determine the chemical nature of the active substances. The discovery of the stability of the vitamins to the somewhat drastic process of saponification was for many

FIG. 2


10,000 g. cod-liver oil
Saponification with alkali
Soaps (inactive)
100 g. unsaponifiable matter (active)
Precipitation with digitonin
50 g. cholesterol (inactive)
50 g. active product
Distilled at 1—2 mm. pressure
B. P. 180° C. (inactive)
B. P. 180–200° C. Vitamin fraction contains traces of inactive spinacene
B. P. 270–280° C. Contains spinacene, $C_{30}H_{50}$ (inactive) and batyl alcohol (inactive)
Residue, 300° C. (inactive)

of us a great relief, because at the back of our mind during our earlier researches we had always held the fear that the units responsible for the effects on the animal organism might be ill-defined, unstable substances, such as the toxins and enzymes are believed to be, and would, therefore, prove extremely difficult to investigate by chemical means with the view to discovering their character.

Figure 2 outlines the main paths by which we have recently attempted to gain light as to the nature of the one principle which seems so necessary for the satisfactory growth of the young animal. The very highly active fraction obtained by fractional distillation at reduced pressure appears to consist to a large extent of higher alcohols with unsaturated molecules, probably open chain in nature. Whether such an alcohol is the active principle or not cannot be said until purer preparations than those that have yet been made are available —the claim recently advanced by the Japanese investigator Takahashi and his colleagues, to the effect that they have isolated the active substance in the pure state and shown it to be an unsaturated alcohol, "biosterin," $C_{27}H_{46}O_2$, cannot be admitted, as a critical examination of their work proves that their preparations were of doubtful purity. The investigation of the unsaponifiable matter from fish liver oils has revealed the fact that higher alcohols are frequently found there, and we have recently been able to show that of those of which the identity has been reasonably well established, namely, selachyl alcohol, $C_{20}H_{40}O_2$, oleyl alcohol, $C_{18}H_{36}O$, batyl alcohol, $C_{20}H_{42}O_2$, and the well-known alcohol, cholesterol, $C_{27}H_{46}O$, no one can be identified with the active principle.

The idea that vitamin A might well be an unsaturated alcohol of this type is not unattractive in some respects, if only for the reason that it seems to yield a number of color reactions, some of which are now being investigated for their value as means of detecting and estimating vitamin A in foodstuffs, which in their general character resemble those which are given by the sterols, the universally distributed higher alcohols believed to be related to the terpenes.

The presence of cholesterol, phytosterol, or similar substances in the unsaponifiable matter or plant or animal fats calls attention to the remarkable extent of our ignorance concerning the function of these substances in the living cell. The literature is congested with a mass of wholly unreliable work on these substances, and no problem in biochemistry calls more urgently for solution than that which concerns their significance in the cell. Even their structures, investigated with great care and precision by Windaus and others for a number of years, have so far resisted all efforts at elucidation. To one *rôle* of cholesterol and the closely related compound phytosterol I would like to draw attention, for it concerns our discussion of the fat-soluble vitamins; incidentally, the story of its discovery is, I think, one of the most interesting that recent scientific advance can provide.

Almost every conceivable type of causative agent has at one time or another been blamed for the onset of rickets, but, broadly speaking, the theories of its etiology can be divided into two main groups.

Of these, one consisted of a variety of views all of which held that in some manner or another defective diet was responsible for the trouble, whilst the other type of theory was based on the belief that faulty hygienic surroundings, in particular, lack of fresh air and sunlight, were the main causative agents.

The supporters of the two contending schools of thought each, in turn, brought forward evidence which to the outside observer seemed equally convincing and for a time no reconciliation seemed possible. In 1916 Huldschinsky demonstrated that rickets in infants could be cured by exposure to the light of a quartz mercury-vapor lamp, well known to be a source of light rich in the short wave-length rays of the ultra-violet part of the spectrum.

Confirmaton of this fact was soon forthcoming, and especially by the researches of Dr. Harriette Chick and her colleagues in Vienna, just after the War, was it shown that the cure of rickets may be achieved with equal success either by such exposure or by the administration of certain foods, such as cod-liver oil.

These facts at first seeming to stand in somewhat uncertain relation to each other, were, in a short time, correlated by the interesting observations of the American investigator Steenbock, who found that the production of rickets in animals by feeding them on a diet deficient in certain constituents could be prevented by previously exposing the food to the rays of an ultra-violet lamp.

At once many of the apparent inconsistencies between the results of the earlier work seemed to disappear.

One by one the constituents of the diet were examined, with the result that the proteins, carbohydrates, and salts were found to be unaffected by the action of the rays in so far as the formation of any substance possessing anti-rachitic action was concerned. When, on the other hand, the fats were examined, a very different story was revealed, for its was found that a number of inactive oils, such as linseed or cotton-seed oil, which in the untreated form exhibit no anti-rachitic powers, became strongly curative after exposure to the light of the quartz mercury-vapor lamp for an hour or two.

Almost simultaneously in this

country and in America the reason for this was discovered, by the observation being made that the precursor of the active substance occurred in the unsaponifiable fraction of the original oil, and that it was actually the sterol.

Specimens of cholesterol or phytosterol, substances which, as you are aware, can be prepared in a state of considerable purity, and which themselves possess no apparent action on the process of deposition of calcium salts in growing bone, assume that property to a marked degree after exposure to the rays of an ultra-violet lamp for comparatively a short time. As you can see from the two specimens before you, the "activated" cholesterol, as we may term it, has lost the beautiful clean white color and well-marked crystalline form of the untreated sample. It shows a depressed melting-point, 143.5° instead of 149.5°, and gives rise to color reactions differing quite appreciably from those of the unchanged material. These facts lead us to believe that the change is a photochemical one. The activation proceeds both in the absence and presence of oxygen, and after as short a time as two hours a sample of cholesterol, provided it is suitably exposed, becomes strongly anti-rachitic. The activated material has as yet been very little examined chemically. The anti-rachitic principle has been separated from the much larger bulk of unchanged cholesterol by the precipitation of the latter substance with digitonin, but the amount obtained was insufficient to be of any value for chemical examination. You will now be in a position to understand why we believe that a reconciliation between the two theories, or groups of theories, regarding the etiology of rickets has been achieved. The similar action on the forming bone of exposing the child's skin to sunlight or the rays of another source of ultra-violet light, or, on the other hand, of administering cod-liver oil, is probably due, we think, to both treatments supplying the same necessary factor vitamin D. In the one case the vitamin is synthesized in the skin from cholesterol, or a closely related substance, by the photochemical action of the rays in the vicinity of $\lambda = 300\ \mu\mu$, whilst in the other the missing factor is supplied direct in the oil.

Let me now turn to the third of the fat-soluble vitamins, spoken of as vitamin E, and discovered quite recently by Prof. H. E. Evans, of Berkeley University, California. This observer noticed that, although young rats would grow to maturity at a normal rate when fed upon an artificial diet containing a balanced mixture of proteins, fats, carbohydrates, salts, and the vitamins A, B, C, and D, they were incapable of showing a normal reproductive power until the ration had been supplemented with certain other foodstuffs.

The distribution of the anti-sterility factor, as it has been termed, in natural foods showed that it could not be identified with any one of the then recognized dietary essentials. Accordingly it was regarded as a new member of the vitamin class and given the distinctive label E.

It is present to a relatively marked extent in the oil that can be expressed or extracted from the germ or embryo of wheat, and, as Evans and Burr have just shown, it survives saponification of that oil and passes into the unsaponifiable fraction. It appears to be the most stable of the vitamins,

for it is unaffected, at least as regards its action on the female rat, by heat, oxygen, or reduction with hydrogen. From the unsaponifiable fraction of wheat oil the cholesterol has been removed without lowering the activity of the material, and the residue has been fractionally distilled; the physiologically important substance passes over at a temperature of about 180° (2 mm.). Nothing is yet known as to its chemical nature.

It may interest you to be given a few of the doses of active preparations of the different fat-soluble vitamins that have been found to satisfy the requirements of the animals used in the tests:—

Vitamin	Rats, Body Weight in g.	Minimum Dose Recorded in g.	Dose Per 100 g. Weight
A	100	0.00001	0.00001
D	100	0.0001	0.0001
E	200	0.0005	0.00025

Of course, it must be admitted that the comparison is to a large extent unjustified, if only because the preparations of the vitamins used were in all cases far from being the active substance in pure state; nevertheless, it is curious that these approximations are of the same order of magnitude.

My reference to Evans' discovery of a vitamin playing an important part in maintaining the delicate balance in the organism on which the reproduction of the species depends calls to my mind another substance with what seem to be not dissimilar properties which also plays a part in that respect. The phenomenon of œstrus or "heat" in the female animal presents many curious and fascinating problems to the physiologist and biochemist, but few of them are, to my mind, of more outstanding interest than that which concerns the mechanism by which the ovaries periodically control the appearance and duration of the characteristic changes in the uterus.

This control is known to be exerted by means of an internal secretion liberated from the ovarian tissue into the circulating blood, for œstrus is at once suppressed by removal of the ovaries.

The chemical substance responsible for these effects can be extracted from the ovaries by certain solvents, and will exert the characteristic action on injection into an ovariotomized animal.

The active principle is a fatty substance, and appears—although this point requires confirmation—to withstand saponification and to pass into the unsaponifiable fraction. The statement has been made that it can be distilled at greatly reduced pressures without serious loss. Once again the biochemist must deplore his ignorance, since the chemical nature of this most interesting substance is quite unknown. Do not, as a body of chemists, treat him with scorn; do not yield to the tendency, marked in some quarters, to pour ridicule on the slimy messes which it is the misfortune—in my heart of hearts I believe it to be a good fortune—of the biochemist to have to deal with.

Remember that over 100 kg. of cod-liver oil had to be saponified, and the unsaponifiable matter extracted in an inert atmosphere, before as little as 300 g. of a preparation suitable for fractional distillation could be obtained; bear in mind that the ovaries of many thousand sheep or pigs must be collected and extracted before a miserable 100 g. of fatty material containing the ovarian hormone can be gathered together; appreciate that at every stage of the

fractionation animal tests requiring three to six weeks may be necessary before the fate of the active substance during the last process that was applied to it can be known. I counsel you to respect these facts lest a worse fate befall you.

In conclusion, let me tell you another curious story in which I and my colleagues are now taking an active interest.

All of you know that the liver acts, in one of its many capacities, as a storage organ of either fats or reserve carbohydrates in the form of glycogen. That is all very well, but I confess my sense of things as they should be in the biological world was greatly surprised when it was shown that certain fish habitually pass their days carrying in their livers as much as 50% of the weight of that organ in the form of a liquid hydrocarbon. This remarkable fact, originally discovered by Mastbaum, but later more fully studied by Tsujimoto and by Chapman, led to the discovery of the hydrocarbon now termed squalene (spinacene) $C_{30}H_{50}$. Its molecule possesses six ethylene bonds, and appears to be an open carbon chain related to the terpenes. Recently in my laboratory Mr. H. J. Channon has discovered another hydrocarbon, apparently of a type resembling that to which squalene belongs, in mammalian livers, but in amounts very much smaller than the quantities of squalene that may be found in fish livers. The significance of these hydrocarbons is as yet unknown, but is being made the subject of study in our laboratories. The amounts present in fish livers may show great variation. Some of the elasmobranch species contain as much as 80% of the total fat of the liver in the form of squalene, whilst other species, often closely related biologically, may only possess a trace.

I have attempted in this paper to present to you an aspect of the chemistry of the fats which possibly may not before have been brought to your notice. The study of the many and curious substances that are found in the unsaponifiable matter of various oils and fats that occur in plant and animal tissues is crying out for attention. For this reason I hope I have interested some of you in what is, to me, a field of chemical research offering problems of fascinating nature and far-reaching importance.

Changes in Olive Oil After Long Standing

(*Continued from page* 140)

mal affinities for iodine of the "unsaturated" oleic and other fatty acids present. The acidity (and Acid No.) has increased about sixteen-fold and undoubtedly much more liberated free fatty acids have been changed to non-acid substances, possibly ketones and aldehydes. Just why the Ester No. (and incidentally the Saponification No.) have increased is not so plain, in view of the fact that there must have been a great loss of glycerol esters during the liberation of free fatty acids.

The data suggests that a hasty condemnation of an old olive oil as "adulterated" is possible and that the history of an abnormally testing oil should be carefully ascertained before prosecution is started.

February Exports of Oleo Oil, Tallow, Oleic Acid or Red Oil, and Other Animal Greases, Oils and Fats, N. E. S.

Countries	Oleo oil Pounds	Tallow Pounds	Oleic acid or red oil Pounds	Other animal greases, oils and fats, n.e.s. Pounds
Belgium	329,462	.....	.....	877,728
Denmark & Faroe Islands	236,069	.....	.....	.....
Germany	1,650,900	.....	.....	156,219
Greece	511,602	.....	.....	28,927
Irish Free State	9,635	.....	.....	.....
Italy	177,480	.....	.....	.....
Netherlands	3,425,128	.....	1,943	4,685,755
Norway	435,808	.....	.....	.....
Sweden	140,903	.....	.....	.....
Switzerland	68,467	.....	.....	.....
United Kingdom	1,920,786	38,765	.....	3,904
Canada	12,600	182,718	11,538	655,894
Costa Rica	.....	40,258	.....	5,163
Guatemala	.....	44,794	.....	48,000
Honduras	.....	8,400	.....	.....
Nicaragua	.....	34,137	.....	.....
Salvador	.....	.....	.....	12,000
Mexico	10,190	103,283	86	137,650
Newfoundland & Labrador	115,734	.....	.....	.....
Other British West Indies	.....	481	.....	.....
Cuba	154,751	2,196	.....	1,621,687
Dominican Republic	.....	137,120	.....	9,493
Danish West Indies	.....	383	.....	288
Haitian Republic	.....	200	.....	.....
Argentina	.....	.....	.....	178
Brazil	28,392	.....	.....	.....
Chile	.....	.....	.....	1,185
Colombia	.....	126,523	.....	4,200
Peru	.....	2,192	.....	.....
Venezuela	.....	.....	.....	100
China	.....	.....	.....	363
Syria	38,039	.....	.....	.....
N. Zealand	.....	.....	.....	8,136
B. W. Africa	100	.....	.....	.....
Quantity	9,266,046	721,450	13,567	8,256,870
Total value	946,850	59,859	1,068	747,582

Exports of Lard Compounds and Oleomargarine During February

Countries	Lard compounds containing animal fats		Oleomargine of animal or vegetable fats		Vegetable oil lard compounds	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Germany	7,200	1,071	.....	.....	.....	.....
Netherlands	32,763	4,660	.....	.....	.....	.....
Norway	89,774	7,290	.....	.....	.....	.....
United Kingdom	337,251	38,792	.....	.....	50	7
Canada	69,160	7,769	.....	.....	1,954	222
B. Honduras	8,728	1,001	400	88	13,383	1,441
Costa Rica	.....	.....	.....	.....	540	92
Guatemala	2,737	346	.....	.....	8,285	1,345
Honduras	1,140	161	.....	.....	7,250	1,218
Nicaragua	5,211	618	.....	.....	1,115	128
Panama	16,875	1,883	28,684	4,936	3,573	645
Mexico	38,875	4,327	1,460	309	184,395	19,387
Newfound. & Lab.	2,688	281	.....	.....	5,281	644
Bermuda	9,348	999	.....	.....	4,613	630
Jamaica	.....	.....	300	52	816	128
Trinidad & Tobago	2,650	336	.....	.....	360	80
Other B. W. Ind.	18,568	2,067	4,865	903	54,611	6,008
Cuba	610,071	62,855	300	75	151,510	17,001
Dominican Rep.	400	60	.....	.....	420	90
D. W. Indies	20,650	2,792	.....	.....	1,975	266
F. W. Indies	10,050	1,350	.....	.....	.....	.....
Haitian Rep.	38,700	5,207	.....	.....	17,100	2,309
Virgin Is. of U. S.	4,305	475	3,764	720	1,164	133
Chile	16,500	1,881	.....	.....	3,300	330
Colombia	.....	.....	.....	.....	902	119
Ecuador	.....	.....	.....	.....	30,422	3,955
Peru	3,300	363	.....	.....	.....	.....
Venezuela	400	60	.....	.....	2,186	382
B. India	.....	.....	.....	.....	180	39
B. Malaya	.....	.....	.....	.....	1,032	243
Ceylon	.....	.....	.....	.....	108	25
China	.....	.....	.....	.....	12,968	3,314
Hongkong	.....	.....	.....	.....	450	105
Japan, inc. Chosen	.....	.....	.....	.....	2,532	559
Persia	.....	.....	.....	.....	408	89
Philippine Is.	16,340	3,100	2,300	583	.....	.....
Siam	.....	.....	.....	.....	1,440	327
Syria	.....	.....	.....	.....	180	39
Australia	.....	.....	.....	.....	11	5
F. Oceania	579	110	.....	.....	2,861	452
N. Zealand	.....	.....	.....	.....	3,491	384
B. W. Africa	7,000	1,038	.....	.....	.....	.....
Egypt	.....	.....	.....	.....	2,500	350
Other Port. Afr.	.....	.....	.....	.....	393	77
Canary Is.	1,100	123	.....	.....	.....	.....
Total	1,372,363	151,015	42,073	7,666	523,759	62,568

Shipments from the United States to Non-Contiguous Territories

	Lard compounds containing animal fats	
	Pounds	Dollars
Alaska	7,561	1,123
Hawaii	58,409	8,736
Porto Rico	3,882	373

Exports of Vegetable Oils, Expressed, During February

Countries	Crude Pounds	Refined Pounds	Corn oil Pounds	Cocoa butter Pounds	Cocoa-nut oil Pounds	Lin-seed oil Pounds	Soy bean oil Pounds
Belgium	.....	52,005	.....	....	.....	.....	.....
Czechoslovakia	.....	61,300	.....	....	.....	.....	.....
Denmark & Fr. Is.	.....	30,168	.....	....	.....	.....	.....
France	.....	280,998	.....	....	.....	.....	.....
Germany	.....	72,072	.....	....	.....	.....	.....
Irish Free State	.....	19,351	.....	....	.....	.....	.....
Italy	.....	.....	35,292	....	.....	75	.....
Netherlands	.....	40,284	.....	....	.....	.....	.....
Norway	.....	482,363	.....	....	.....	.....	.....
Sweden	.....	127,771	.....	....	.....	.....	.....
United Kingdom	63,689	19,375	.....	....	.....	.....	.....
Canada	5,426,146	51,921	3,192	288	447,555	8,114	1,062
B. Honduras	.....	340	.....	....	.....	.....	.....
Costa Rica	.....	.....	.....	....	3,688	894	16,500
Guatemala	.....	9,260	.....	200	.....	2,850	25,075
Honduras	.....	3,095	.....	....	.....	2,224	.....
Nicaragua	.....	469	.....	....	20,400	2,726	.....
Panama	.....	14,813	.....	72	841	91,542	13,125
Salvador	.....	1,875	.....	96	.....	.....	.....
Mexico	60,100	66,713	1,464	134	454,035	24,067	6,000
Newfound. & Lab.	.....	38,939	.....	....	385	4,287	.....
Bermuda	.....	1,413	406	....	.....	319	.....
Jamaica	.....	7,425	.....	....	.....	.....	.....
Trinidad & Tobago	.....	150	.....	....	.....	.....	.....
Other B. W. Ind.	.....	1,077	740	....	.....	1,386	.....
Cuba	.....	383,593	1,221	797	71,768	38,411	82,410
Dominican Rep.	.....	6,275	5,700	....	9,390	3,810	10,650
D. W. Indies	.....	11,650	.....	....	.....	.....	7,500
F. W. Indies	.....	48,000	.....	....	.....	.....	.....
Haitian Rep	.....	7,920	.....	....	.....	4,915	20,465
Virgin Is. of U. S.	.....	375	245	....	.....	.....	825
Argentina	.....	142,928	.....	....	2,219	.....	.....
Chile	.....	277,952	.....	....	.....	.....	.....
Colombia	.....	12,900	2,537	864	4,597	15,796	4,800
D. Guiana	.....	54,163	.....	....	.....	.....	.....
Paraguay	.....	.....	1,000	....	.....	.....	.....
Peru	.....	.....	.....	150	4,535	6,904	.....
Venezuela	.....	.....	70	....	.....	18,161	.....
Aden	.....	.....	900	....	.....	.....	.....
B. Malaya	.....	259	.....	....	.....	.....	.....
B. India	.....	.....	.....	....	.....	.....	2,250
Ceylon	.....	1,170	.....	....	.....	.....	.....
China	.....	27,525	.....	....	.....	8,370	.....
Hongkong	.....	9,777	.....	....	.....	.....	.....
Japan, inc. Chosen	.....	121,985	.....	....	7,700	.....	.....
Philippine Is.	.....	86,154	.....	500	.....	.....	.....
Australia	.....	3,975	.....	332	.....	11,400	.....
B. Oceania	.....	.....	.....	....	.....	150	.....
F. Oceania	.....	545	96	....	.....	2,790	.....
N. Zealand	.....	.....	.....	....	37,658	.....	4,350
B. S. Africa	.....	675	1,800	....	.....	.....	42,048
B. W. Africa	.....	.....	.....	....	.....	173	.....
Portuguese E. Afr.	.....	.....	.....	....	.....	.....	5,400
Quantities	5,549,935	2,580,998	54,663	3,433	1,064,771	249,363	242,460
Total Values	441,908	262,387	4,659	1,812	90,117	30,317	31,806

Shipments from the United States to Non-Contiguous Territories

	Cottonseed		Linseed	
	Pounds	Dollars	Pounds	Dollars
Alaska	.....	....	16,300	1,810
Hawaii	67,520	9,201	43,172	5,178
Porto Rico	17,404	2,043	63,257	7,518

Imports of Olives, Coconut Meat and Coconut Oil, Peanuts and Peanut Oil and Edible Olive Oil During January

Countries	Olives in brine		Coconut meat dessicated, shredded, cut or similarly prepared	
	Gallons	Dollars	Pounds	Dollars
France	24	73	.....	.....
Germany	.....	.....	6,500	579
Greece	4,476	3,119	.....	.....
Italy	39,573	16,190	.....	.....
Netherlands	.....	.....	.....	.....
Portugal	13	10	.....	.....
Spain	457,551	418,494	.....	.....
United Kingdom	.....	.....	.....	.....
Canada	.....	.....	.....	.....
British Honduras	.....	.....	.....	.....
Panama	.....	.....	.....	.....
Jamaica	.....	.....	.....	.....
Cuba	8	12	.....	.....
Dominican Republic	.....	.....	.....	.....
Colombia	.....	.....	.....	.....
British Malaya	.....	.....	.....	.....
Ceylon	.....	.....	1,987,535	163,366
China	.....	.....	.....	.....
Hongkong	97	75	280	31
Japan, including Chosen	.....	.....	.....	.....
Palestine	530	327	.....	.....
Philippine Islands	.....	.....	2,967,680	260,402
Syria	962	601	.....	.....
British Oceania	.....	.....	.....	.....
French Oceania	.....	.....	.....	.....
Egypt	500	350	.....	.....
Total	503,734	439,251	4,961,995	424,378

OLIVE OIL, EDIBLE

Countries	In packages of less than 40 pounds		In other packages	
	Pounds	Dollars	Pounds	Dollars
France	152,475	35,634	104,291	25,313
Greece	.....	.....	140	25
Italy	2,340,164	463,936	914,530	203,914
Netherlands	96	30	.....	.....
Spain	119,335	23,954	1,293,408	258,568
Switzerland	20,565	4,347	1,369	318
Palestine	.....	.....	80	11
Syria	1,756	251	.....	.....
Turkey in Asia	.....	.....	1,440	176
Algeria and Tunisia	.....	.....	135,190	27,777
Total	2,634,391	528,152	2,450,448	516,102

Countries	Copra		Coconut oil	
	Pounds	Dollars	Pounds	Dollars
France	.....	.....	.....	.....
Germany	.....	.....	.....	.....
Greece	.....	.....	.....	.....
Italy	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....
Portugal	.....	.....	.....	.....
Spain	.....	.....	.....	.....
United Kingdom	.....	.....	.....	.....
Canada	35,658	1,702	.....	.....
British Honduras	109,200	4,377	.....	.....
Panama	1,860	99	.....	.....
Jamaica	6,825	301	.....	.....
Cuba	.....	.....	.....	.....
Dominican Republic	.....	.....	100	10
Colombia	5,394	270	.....	.....
British Malaya	8,377,828	384,649	.....	.....
Ceylon	.....	.....	.....	.....
China	.....	.....	.....	.....
Hongkong	.....	.....	.....	.....
Japan, including Chosen	662,258	28,723	.....	.....
Palestine	.....	.....	.....	.....
Philippine Islands	25,780,694	1,168,689	31,588,223	2,512,563
Syria	.....	.....	.....	.....
British Oceania	1,687,359	75,633	.....	.....
French Oceania	2,695,678	120,596	.....	.....
Egypt	.....	.....	.....	.....
Total	39,362,754	1,785,039	31,588,323	2,512,573

PEANUTS

Countries	Shelled		Not shelled		Peanut oil	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
France	.....	.....	.....	.....	110,168	12,005
Germany	17,223	935	.....	.....	.....	.....
Greece	.....	.....	.....	.....	.....	.....
Italy	.....	.....	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....	1,998	225
Portugal	.....	.....	.....	.....	.....	.....
Spain	.....	.....	8,102	779	.....	.....
United Kingdom	18,904	1,947	.....	.....	.....	.....
Canada	.....	.....	.....	.....	.....	.....
British Honduras	.....	.....	.....	.....	.....	.....
Panama	.....	.....	.....	.....	.....	.....
Jamaica	.....	.....	.....	.....	.....	.....
Cuba	.....	.....	.....	.....	.....	.....
Dominican Republic	.....	.....	500	35	.....	.....
Colombia	.....	.....	.....	.....	.....	.....
British Malaya	.....	.....	.....	.....	.....	.....
Ceylon	.....	.....	.....	.....	.....	.....
China	3,196.100	135,531	1,062.706	39,719	576	66
Hongkong	4,512	511	7,360	838	156,062	18,373
Japan, including Chosen	200,400	8,023	13,500	786	.....	.....
Palestine	.....	.....	.....	.....	.....	.....
Philippine Islands	.....	.....	.....	.....	.....	.....
Egypt	.....	.....	.....	.....	.....	.....
Total	3,437,139	146,947	1,092,168	42,157	268,804	30,669

Abstracts from Other Journals

DAVID WESSON, *Abstract Editor*

Properties of Cholesterol Obtained from Different Sources. R. J. Anderson. (*J. Biol. Chem.*, 1927, 71, 407-418.)—Attention is called to the fact that cholesterol preparations obtained from different sources show slight differences in physical properties. In order to determine whether different cholesterol preparations are homogeneous it would be necessary to prepare cholesterol esters of various acids or some other derivatives of cholesterol, fractionally recrystallize them, and compare the properties of the different fractions. When apparently pure cholesteroyl acetate was fractionally recrystallized from ethyl alcohol a bottom fraction was separated which possessed a much lower melting point and a lower optical rotation than the top fraction—probably due to a small amount of a substance having a lower rotation than ordinary cholesterol. It is possible that a derivative other than the acetate, and a solvent better than alcohol might be found that would cause a more effective separation. If cholesterol is formed from plant sterols, a number of different, as well as isomeric, cholesterols might be expected to occur in animal fats, corresponding to the various phytosterols contained in the plant material which serves as food. P. H. P.

Distribution of Dihydrositosterol in Plant Fats. R. J. Anderson, F. B. Nabenhauer and R. L. Shriner. (*J. Biol. Chem.*, 1927, 71, 389-399.)—Previous work on the sterols is discussed. The saturated sterol, dihydrositosterol, $C_{27}H_{47}OH$, appears to be rather widely distributed in plant fats. It occurs in association with unsaturated sterols, not only in the endosperm and bran of maize and wheat, but also in small amounts in the oils obtained from the germ of these grains. Appreciable quantities of the substance have been isolated from maize gluten, maize bran, wheat bran, rice bran, maize oil and wheat germ oil. The dihydrositosterol preparations that have been obtained from different sources show slight variations in physical properties. The melting points vary from 141-142° to 145-146° C., and the specific optical rotations vary from about +23° to +25°. The acetyl derivatives vary in melting points from 137° to 141° C., and in optical rotation from about +13° to +14°. Whether these variations in properties depend upon the degree of purity or are due to the presence of isomeric saturated sterols, cannot be determined from the present data. The dihydrositosterol which occurs in plant fats appears to be identical with the synthetic sitostanol which is obtained when an unsaturated sterol, which possesses the properties usually ascribed to sitosterol, is reduced with hydrogen in the presence of platinum black. The properties and composition of the various dihydrositosterol preparations that have been isolated are summarized in a table in comparison with the synthetic sitostanol.

YOU *MUST* BE SURE

to attend the annual meeting of the American Oil Chemists' Society in New Orleans, May 11. Headquarters are at the HOTEL ROOSEVELT.